GASCOYNE INLET GEOSCIENCE PROJECT

Technical Project Description

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The proposed research aims to generate an integrated understanding of the marine, coastal, and terrestrial geological environments surrounding the Gascoyne Inlet Camp (GIC) to support safe operations, infrastructure planning, and long-term environmental monitoring for Defence Research and Development Canada (DRDC). In the short term, the project seeks to establish improved knowledge of seabed composition, coastal and sediment dynamics, surficial geology and permafrost conditions, and natural underwater acoustic noise in the region. Over the longer term, the research will contribute to improved Arctic domain awareness, enhanced detection and interpretation of underwater acoustic signals, and strengthened resilience of northern infrastructure by distinguishing natural geological processes from anthropogenic features and hazards. This work is motivated by DRDC's need for accurate, high-resolution environmental information to support operational readiness in Arctic waters, and by the Geological Survey of Canada's (GSC) ongoing efforts to document the geological framework and environmental processes shaping Nunavut's coastal and nearshore regions. Previous GSC studies across the territory have demonstrated the importance of understanding sediment transport, seabed instability, permafrost degradation, and natural acoustic noise, all of which influence both infrastructure vulnerability and the performance of underwater sensing systems. As DRDC evaluates potential expansion of the GIC, a comprehensive understanding of the surrounding terrain including the coastal zones and offshore environments, has become increasingly important.

Gascoyne Inlet has been an area of interest for research related to nearshore ice and coastal dynamics since the 1960's. Over the past six decades GSC researchers have conducted extensive seabed and coastal investigations across Nunavut, and the present project builds directly on this foundation. Progress to date includes a reconnaissance visit to GIC in summer 2025, during which three geoscientists completed remotely piloted aircraft system (RPAS) surveys of the camp, airstrip, and existing GSC coastal monitoring sites, and conducted ground-penetrating radar (GPR) surveys in key areas around the camp and along the airstrip. These activities provided essential reconnaissance information on site accessibility, logistical constraints, and initial environmental conditions. Concurrently, the team examined legacy datasets in preparation for expanded fieldwork in 2026 and 2027. This work included reviewing historical air photographs and satellite imagery, compiling existing marine data from Gascoyne Inlet and Radstock Bay (including nearshore ice conditions using Canadian Hydrographic Survey (CHS) charts and Synthetic Aperture Radar (SAR)), assessing equipment feasibility, and reviewing regional ground-ice modelling for Devon Island.

Fieldwork will commence in earnest in summer 2026, with operations planned for a mid-July to late-August window, subject to weather, vessel schedules, and logistical availability at GIC.

Marine and terrestrial components will be conducted at different times depending on ship access and accommodation capacity. The marine program will be carried out using the CCGS Amundsen and the Nuliajuk research vessel, with permitting for the Amundsen coordinated through the Amundsen Science team and Nuliajuk operations coordinated through this permit in collaboration with the Government of Nunavut. Boarding of the Nuliajuk will occur in Pond Inlet. Coastal and marine activities will extend beyond Gascoyne Inlet itself to include the waters and beaches of Radstock Bay, Cape Ricketts, and Beechey Island, where coastal change, sediment dynamics, and seabed conditions will be documented. Planned methods include single-beam and multibeam bathymetry, shallow sediment coring, deployment of acoustic moorings, RPAS-based Light Detection and Ranging (LiDAR) surveys, installation of time-lapse cameras and offshore gauges, detailed ground truthing and sample collection, shallow permafrost coring, sediment characterization, ground-ice investigations, and installation of shallow ground-temperature loggers. These techniques will support the development of surficial geology maps, assessments of terrain stability, and improved understanding of Quaternary processes, seasonal thaw, and marine geohazards such as turbidity currents, submarine landslides, and porewater freezing.

All scientific personnel are employees of the Geological Survey of Canada and were selected internally through established federal staffing processes based on their technical expertise and alignment with the project's three geoscience streams. Brendan O'Neill, a Research Scientist specializing in permafrost, will lead permafrost-related data collection and ground-ice characterization. Rod Smith, a Research Scientist specializing in Quaternary geology, will conduct sediment sampling, and surficial geology mapping. Gavin Manson, a Coastal Geoscience Specialist, will focus on coastal change mapping, nearshore wave and ice observations, and bathymetric mapping. Alexandre Normandeau, a Marine Geoscience Research Scientist, will lead seafloor mapping and analysis of marine sedimentary bedforms. In addition, the project will recruit a Wildlife Monitor from Resolute Bay through the local Hunters and Trappers Association (HTA). The Wildlife Monitor will accompany the field crew during on-land and nearshore activities and will be invited to participate in both marine and terrestrial components. Recruitment will occur by contacting the HTA directly, providing a description of the field schedule and duties, and requesting that the organization identify a qualified community member. This approach ensures that Inuit knowledge is integrated directly into field operations and that all activities respect wildlife, environmental conditions, and community expectations.

Ethical research protocols will be followed throughout the project, including pre-season engagement with community organizations in Resolute Bay and, if desired, Pond Inlet or Arctic Bay, and the incorporation of Inuit knowledge into site selection, interpretation of environmental change, and validation of results. A pre-field meeting is being planned for April or early May in Resolute Bay, with additional meetings in other communities if there is interest. All field activities will adhere to NRCan wildlife and safety protocols, and the project will operate under an existing Memorandum of Understanding between DND/DRDC and GSC, valid until March 2028.

Data management will follow Government of Canada data stewardship standards and the requirements of the Nunavut Research Institute. The project does not involve collecting personal information; all data consist of environmental, geophysical, and geological observations such as RPAS imagery, bathymetry, sediment cores, ground temperatures, GPR profiles, and coastal measurements. These datasets will be stored on secure servers managed by Natural Resources Canada and DRDC, with access restricted to authorized personnel. Data will be shared internally between the two organizations through established federal procedures. Any local knowledge shared by community members will be documented only with consent and will not be released publicly without community approval. Scientific datasets intended for public release, including surficial geology maps, coastal change analyses, and Open File reports, will be published through NRCan's standard channels following review and validation. Before release, relevant findings will be shared with community organizations in Resolute Bay to ensure accuracy and appropriate interpretation.

Following each field season, the team will process and analyze the collected data to generate a suite of research outputs, such as isopach maps of seafloor sediment, surficial geology maps, reports on marine geological processes, documentation of coastal change and sediment disturbance, SAR-based assessments of seasonal thaw and surface elevation change, analysis of camera and seabed instrument data, modelling investigations, laboratory analysis and dating of field samples, refined ground-ice mapping, and DInSAR-based terrain stability assessments. By March 31, 2028, the project will produce a comprehensive final report synthesizing all analyses and interpretations. Research outputs will include academic publications, presentations, maps, datasets, and technical reports. Results will be validated with and communicated to the public and affected organizations in Nunavut through community presentations in Resolute Bay and through the public release of an Open File report, ensuring that findings are accessible, transparent, and directly beneficial to northern communities and stakeholders.